Hurricane Ian: How climate change is making North Atlantic tropical storms worse

October 4 2022, by Ben Clarke and Friederike Otto

Hurricane Ian, as seen from the International Space Station on September 28 2022. Credit: NASA Photo/Alamy Stock Photo

Hurricane Ian first made landfall in western Cuba as a category 3 storm, wiping out power for 11 million people. It continued northwards over the Gulf of Mexico where it strengthened over exceptionally warm ocean water (which meteorologists describe as "rocket fuel" for hurricanes).

On reaching the coast of Florida, Ian made landfall as a category 4 storm

with winds of up to 249km/h (155mph) as well as storm surges and torrential rain.

But Ian wasn't finished there. The hurricane carved a path of destruction across the state before sweeping back out to sea, where it refueled and turned northwards, striking South Carolina and driving deeper into the U.S.

Ian cut power to 2.7 million homes in Florida alone. Millions of people were evacuated ahead of time, but many stayed and the death toll is thought to be high. Though the extent of damage is not yet known, it is probably in the tens of billions of dollars and may exceed a hundred billion dollars, as only a few storms have before.

Devastating hurricanes are often seen as an indication that global warming is intensifying. While this makes a compelling headline, exactly how, where and when climate change affects extreme weather is more complex. Understanding these complexities can help countries and communities decide how to adapt to mounting storms—and when it's better to make the difficult choice to relocate.

How do hurricanes form?

Most hurricanes in the North Atlantic begin as low-pressure weather systems moving off the west coast of Africa towards the Caribbean.

A specific set of conditions is necessary for these seeds to evolve into hurricanes: warm, moist air, winds that are fairly consistent in the upper and lower atmosphere, and, most importantly, a seawater temperature above 27°C. This is the lifeblood of a hurricane and provides all of its energy.

Warm, moist air and high ocean temperatures are in ample supply in a

rapidly warming world. Yet there is no evidence that hurricanes are happening more often, nor do scientists expect this to change with further climate change.

Instead, those that do occur are more likely to be major hurricanes (categories 3 to 5 on the Saffir-Simpson scale). Each successive category on this scale has far more destructive potential than the previous one.

Because ocean temperatures are warming everywhere, conditions that breed hurricanes are now found further north and south of the equator than they used to be. And hurricanes form outside the seasons people once expected them.

There is also evidence that they are moving more slowly, and are increasingly likely to completely stall near the coast, leading to more flooding as more rain is dumped over one place. This was one reason why Hurricane Harvey, which struck Texas and Louisiana in 2017, was so destructive.

But what does all of this mean for how people experience hurricanes?

Brave new whirls

It is well-established that a warmer atmosphere holds more moisture—about 7% more for each degree celsius of temperature rise. Combined with the observed slowing, this means hurricanes, which are already responsible for some of the heaviest rainfall on the planet, tend to dump a vast amount of extra water in a warmer world.

Scientists have studied the rainfall from several recent storms and consistently confirmed this pattern. The rainfall totals from Hurricanes Katrina, Irma, Maria, Harvey, Dorian and Florence were all made more intense by climate change.

Together, these storms were responsible for over a half-trillion dollars in damage. In the case of Harvey, the amount of extra rain due to climate change was 15%—over twice as much as one would expect from warmer air temperatures alone.

To date, there has been no significant increase in hurricane wind speeds due to climate change. But a landmark study on storms Katrina, Irma and Maria showed that by the end of the century, the wind speeds of similar storms would be around 24km/h (15mph) faster, as hurricanes draw more power from warmer waters and can sustain more intense low pressure in the atmosphere.

Hurricanes that move more slowly also expose people and properties to powerful winds for longer, even if the winds themselves are not amplified.

Hurricane Sandy struck New York and the eastern seaboard of the U.S. in autumn 2012, causing more than US$60 billion (£53.5 billion) in damages. Since that disaster, scientists have calculated that sea level rise due to global warming increased the height of the storm surge significantly. In doing so, it directly affected 71,000 extra people and led to an additional US$8.1 billion in damage.

The elevated surge experienced during Sandy is replicated to some degree in every hurricane. In Florida's Fort Myers, average sea levels are now around 0.15 meters (half a foot) higher than they were in 1965.

This and neighboring Cape Coral, known as the "Waterfront Wonderland" for its extensive coastal development, remain two of the U.S.'s fastest growing cities. The latter has been built over mangrove swampland that provides natural storm protection and is one of the greatest natural carbon sinks.

As winds become more powerful, they could whip up even bigger storm surges in the future. In this way, several of the effects of climate change on hurricanes compound one another.

> This time-lapse video by Max Olson shows what a 4.5 meter (15 feet) storm surge looks like. The video was recorded in Ft. Myers Beach, Florida during hurricane Ian landfall
>
> [full video, HD, Max Olson Chasing: https://t.co/gObjp3BBxF] pic.twitter.com/0PW90SKC7Z
>
> — Massimo (@Rainmaker1973) September 30, 2022

The fossil fuel premium

Scientists are increasingly capable of pinning a price on the influence of greenhouse gas emissions on some extreme weather events. North Atlantic hurricanes are a critical case, both because of the strong evidence for their link to climate change and the sheer scale of the destruction they unleash.

Based on the existing science, we believe it is now reasonable to approximate the damages due to climate change. In the case of each intense hurricane that makes landfall like Ian, especially when it strikes densely populated areas, climate change is probably responsible for extra damages on the order of US$10 billion, as well as disruption to the lives of tens to hundreds of thousands more people.

Florida, like much of the Caribbean and the eastern U.S., is in a precarious position. Recent efforts to avert coastal flooding will no doubt ameliorate some of the worst effects of Hurricane Ian and pay dividends in storms for years to come. But tackling these symptoms is futile if the ultimate cause—greenhouse gas emissions—remains

unaddressed.

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